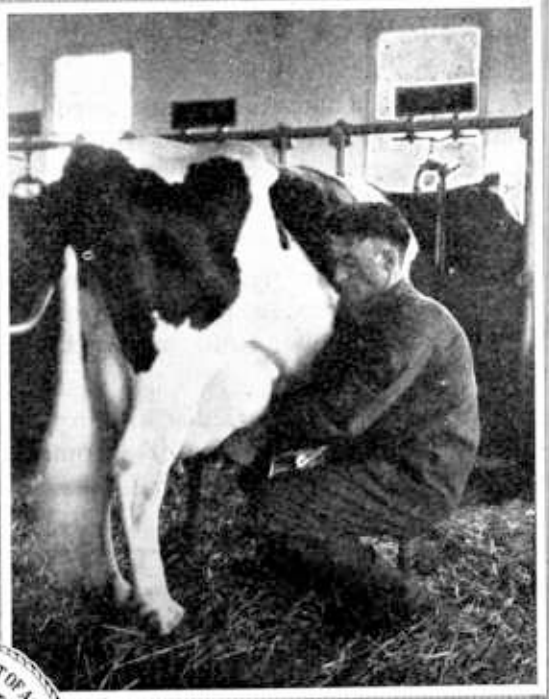
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 602

PRODUCTION OF CLEAN MILK



CLEAN MILK is milk of good flavor from healthy cows, that is free from dirt and contains only a small number of bacteria, none of which are harmful.

Bacteria are tiny, single-celled plants, invisible to the naked eye. So far as possible they should be kept out of milk, and those that do get in should be prevented from multiplying by promptly cooling the milk.

Bacteria dangerous to human health may come from unhealthy cows and milkers, contaminated water supplies, flies, or filth.

Great numbers of bacteria may be introduced into milk from the body of the cow and from unsterilized utensils. Easily applied preventives are cleaning the cows, the use of small-top milk pails, and sterilization of utensils.

Prompt cooling to low temperatures prevents bacterial growth and aids in producing better milk, which will keep longer and make finer dairy products.

Clean, well-constructed stables aid in producing clean milk, as does a separate milk room in which the product is handled.

Washington, D. C. Issued August, 1914; revised July, 1929

PRODUCTION OF CLEAN MILK

By ERNEST KELLY, *Chief, Division of Market-Milk Investigations, Bureau of Dairy Industry*

CONTENTS

ECONOMIC IMPORTANCE OF CLEAN MILK

NO GREATER FIELD of usefulness exists than the production of milk for human food. Milk is a good food for growing children. It helps to make them strong, useful citizens. Adults, too, especially invalids and those weakened by improper nourishment, need milk in the diet to repair waste and build up strong new tissue. Recent investigations in nutrition have shown that milk contains certain dietary factors, called vitamins, which are essential for the proper growth and health of the human body.

Milk production also carries responsibilities. When carelessly produced and improperly handled milk may be the means of spreading disease. Every owner of a dairy herd should consider it his duty to himself and to the community to keep only healthy cows, supply them with wholesome feed, and keep them in clean, comfortable quarters.

The milkers and all who handle milk should realize that they have in their charge a food which is easily contaminated and therefore should take all reasonable precautions to prevent it from becoming a source of danger to themselves and others.

BACTERIA IN MILK

All milk, unless collected under very exceptional circumstances, contains some bacteria (single-celled plants so small that they can not be seen with the naked eye). Milk furnishes all the food ma-

terial and other necessary conditions for bacterial growth. The bacteria commonly found in milk grow most rapidly at temperatures between 80° and 100° F. Some bacteria, at maturity, divide to form two bacteria, and under favorable conditions the two new individuals may become full grown and repeat the process of division in from 20 to 30 minutes. At temperatures below those most favorable the growth of bacteria is retarded but continues slowly, except at very low temperatures. Growth at 70°F. is rapid, at 50°F. it is much retarded, and at 40° F. or below it is very slow. A few kinds of bacteria continue to grow, however, even at the freezing point.

Many of the bacteria ordinarily found in milk produce no apparent change in it. Other kinds may change the flavor without changing the appearance, while some of the most common types of bacteria cause marked changes in both appearance and flavor. In the latter class are included the bacteria which sour milk by converting the milk sugar into lactic acid, and those which form a sweet curd. Another type of bacteria decomposes the casein and albumen in the milk and causes putrefaction and bad odors.

The number of bacteria in milk, depends, first, on the number of bacteria in the udder of the cow, secondly, on the amount of contamination from outside sources, and thirdly, on the rapidity of the bacterial growth. The rate of growth or increase depends on the temperature at which the milk is held.

DEFINITION OF CLEAN MILK

While a rigid application of the definition of the word "clean" would exclude milk which contains foreign matter or any bacteria whatever, for ordinary purposes we may understand that **clean milk is milk of good flavor from healthy cows, that is free from dirt and contains only a small number of bacteria, none of which are harmful.**

IMPORTANCE OF CLEAN MILK TO THE CONSUMER

The consumer is interested in clean milk primarily because no one cares to use a food which is not produced and handled under sanitary conditions. He has a more direct interest, however, because of the danger of contracting disease which may be communicated by the use of contaminated milk. Serious epidemics of typhoid fever, septic sore throat, and other diseases have been spread through milk which was not carefully produced or properly pasteurized. The weight of scientific evidence at present indicates that tuberculosis may be transmitted from animals to human beings, chiefly young children, by the consumption of raw milk containing tubercle bacilli. (Raw milk is milk that has not been pasteurized.)

Cleanliness is not an absolute safeguard against disease, but it is a great factor in preventing contamination. From a health point of view, there is danger not only from milk that contains the specific disease-producing bacteria previously mentioned, but also from milk that contains large numbers of miscellaneous bacteria, which may cause serious digestive troubles, especially in infants and invalids, whose diet consists chiefly of milk. A minor consideration is the loss

to the consumer from milk souring or otherwise spoiling before it can be used. **The cleaner the milk the longer it will keep good and sweet.**

IMPORTANCE OF CLEAN MILK TO THE PRODUCER

Clean milk benefits not only the consumer but the milk producer as well. Most producers of market milk have experienced the loss of having a shipment of milk refused or returned because it reached the market sour, tainted, or otherwise in poor condition. Although the milk may be used for feeding pigs, it usually is a complete loss to the producer, since the cost of transportation back to the farm usually exceeds the value of the milk. Frequently, also, the producer depends on a certain market as an outlet for his milk and has no means for utilizing small quantities at uncertain intervals at the farm. Another important consideration is the unpleasant effect which the receipt of sour, tainted, or otherwise unsalable milk has upon the purchaser. Delivering milk of that kind usually results in the loss of the confidence of the dealer, or, if it is delivered directly to the consumer, the loss of customers. Clean milk means fewer complaints, a better class of patrons, and a steady market for the product.

To safeguard the purity of the milk is, in several ways, a protection to health on the farm: First, the health of the members of the farmers' family, who use a portion of the milk; and, second, the health of the calves, which live largely on milk. **Healthy cows to breed from and pure milk to feed from** are two important factors in rearing thrifty calves and in the development and maintenance of a healthy and profitable herd. Aside from these immediate and definite benefits there is another consideration, not immediately measurable but of much influence. No one can learn to produce good, clean milk without learning proper methods of care and management of the herd, and the study of these things leads to greater care in managing the business.

PROTECTION FROM SPECIFIC DISEASES

It has long been recognized that milk may carry bacteria which can cause disease in human beings. These bacteria may come from the cow or the milker, or from other sources on the farm.

HEALTH OF CATTLE

Remove tuberculous cattle.

Tuberculosis probably is the most dangerous and widespread disease of cattle that can endanger the safety of milk. The following quotations from Farmers' Bulletin 473 on tuberculosis give an idea as to its danger to human health as well as its disadvantages to cattle owners:

> Tuberculosis is contagious, or "catching." It spreads from cow to cow in a herd until most of them are affected. This may not attract much notice from the owner, as the disease is slow to develop, and a cow may be affected with it for several months and sometimes years before any signs of ill health are to be seen.
>
> The calves in such a herd do not long remain healthy. They catch the disease before they are many months old, and are a source of loss instead of gain.

Regarding the losses from tuberculosis the same bulletin states:

> The aggregate of these losses among cattle and hogs is enormous, amounting to millions of dollars every year, besides materially decreasing the food supply of the country.

Tuberculosis in dairy cows, especially when the udder is affected, may be the cause of tuberculosis in human beings. Most of the tuberculosis of children is of the bones, joints, and digestive tract, leading to the theory that milk may be one of the chief causative agents. In adults most of the tuberculosis found affects the lungs.

Cows should be tested for tuberculosis at least once a year by a capable veterinarian, and if disease is found the test should be made twice a year. All cows which react, showing that they are infected with the disease, should be removed from the herd and the stable and premises thoroughly disinfected.[1] All animals purchased for the herd should be tuberculin tested before they are brought to the farm. Even then they should be kept separate from the other animals for at least 60 days and retested before being placed with the herd.

No slimy, ropy, or watery milk, or milk which is abnormal in any respect, or which comes from an animal that appears sick or out of conditon, should be consumed by human beings. As a rule milk from a cow 15 days before calving or during the first 5 days after calving should not be used. It is well not to use milk from cows that have been given powerful drugs which may pass into the milk.[2]

HEALTH OF MILK HANDLERS

Those who handle milk should be healthy.

Some communicable diseases which do not originate with the cow may be carried by milk. The bacteria causing these diseases drop into the milk, are introduced unknowingly by the milker, are carried by flies, or come from contaminated utensils. Many of these bacteria grow in milk, and "milk-borne" epidemics have been caused by them. Diseases which may be carried by milk include: Tuberculosis, typhoid fever, diphtheria, scarlet fever, and septic sore throat. Bacteria causing these and other diseases can be carried by people who are apparently well, or at least are well enough to perform their work.

Great care must be taken to have only healthy people handle milk or anything with which it may come into contact. No one should go from a sick room where an infectious disease exists to take part in any dairy operations.

WATER SUPPLY

Have pure water.

The water supply of dairy farms should be carefully examined and its purity established. The farmer owes this protection to his own family, to his business interests, and to those who use milk that comes from his dairy. Contamination of water may lead to typhoid fever. All water on the farm, even that to which only the cattle have access,

---

[1] Directions for disinfecting stables are given in Farmers' Bulletin 954.

[2] The following bulletins deal with cattle diseases. While not of direct bearing on the cleanliness of milk, they are of interest to dairymen. Farmers' Bulletin 206, Milk Fever. Farmers' Bulletin 569, Texas Fever. Farmers' Bulletin 666, Foot-and-Mouth Disease. Farmers' Bulletin 1017, Cattle Scab. Farmers' Bulletin 1018, Hemorrhagic Septicemia. Farmers' Bulletin 1069, Tuberculosis in Live Stock.

should be above suspicion as to its purity. If cows wade in polluted water, disease bacteria may adhere to their bodies and later fall into the milk pails. Especial attention should be paid to the purity of the water with which milk pails and other utensils are washed.[4]

DISPOSAL OF WASTE

Dispose properly of stable manure and privy deposits.

Disease may be spread from farm to farm and milk may become infected if care is not taken in the disposal of wastes from human beings and domestic animals. Disease-producing bacteria may be carried from exposed excreta by flies, rats, birds, etc., or they may be washed into the water supply. For this reason stable manure and privy deposits should be properly disposed of.

Whenever possible, stable manure should be hauled directly to the field and spread at once. When this is not feasible a covered storage pit or bin may be provided at a distance from the stable and milk house. Such treatment of manure not only is a health measure but it is an economy in farm practice, as it reduces waste of valuable fertilizing materials. (See fig. 1.)

The proper disposal of human excreta is highly important and it is easily accomplished in a number of ways. Indoor toilets, either chemical or connected with a sewerage system,[5] are practicable for farm homes. If privies are used they should be of a sanitary type [6] and the contents should be frequently removed and either burned, treated with powerful chemicals, or buried.

FLIES

Fight the fly.

The fly is one of the greatest enemies of health. Flies breed in filth and from it they may carry contagion into our houses and to the food we eat. They are usually abundant on dairy farms, being attracted by the cattle, accumulations of manure, spilled milk, and other feeding or breeding grounds. Special care should be taken to exclude them from places where milk is handled and stored, for if they gain access to milk or walk over milk utensils they may leave dangerous contamination. Breeding places should be destroyed or rendered harmless,[7] and measures taken to screen flies from dairy rooms and to trap or catch them.[8, 9]

PREVENTION OF HIGH BACTERIAL COUNTS IN MILK

Keep down the bacterial count in your milk.

Farmers should produce and market milk and cream having a low bacterial count.[10] In most places health regulations require it for the

---

[4] Farmers' Bulletin 1426, Farm Plumbing.
[5] Farmers' Bulletin 1426, Farm Plumbing. Also Cornell Reading Course, Vol. III, No. 59, Sanitation Series No. 4, Sewage Disposal for Country Homes.
[6] Public Health Bulletin 89, United States Public Health Service. A Sanitary Privy System for Unsewered Towns and Villages.
[7] Farmers' Bulletin 1408, The House Fly.
[8] Farmers' Bulletin 734, Flytraps and Their Operation.
[9] Farmers' Bulletin 1097, The Stable Fly.
[10] The bacterial count represents the number of bacteria found in a cubic centimeter (c. c.) and is determined by allowing the bacteria from a definite quantity of milk to grow on a culture medium and counting the number of colonies, each of which represents the growth from one bacterium.

protection of the consuming public. High bacterial counts usually result in economic losses from sour milk and low-grade dairy products. Such low-grade products sell at a lower price and tend to limit consumption.

Many factors enter into the production of milk of a low bacterial content, but recent investigations have demonstrated that the use of a few simple precautions will result in satisfactory control of bacterial contamination and growth. The more important factors which reduce the bacterial count to the greatest degree with the smallest outlay of time and money are described below.

In market milk most of the bacteria come from the body of the cow and from unclean milk utensils. Under certain conditions the bacterial count may be very large, because of bacterial multiplication. The following grouping of "major factors" may be made:

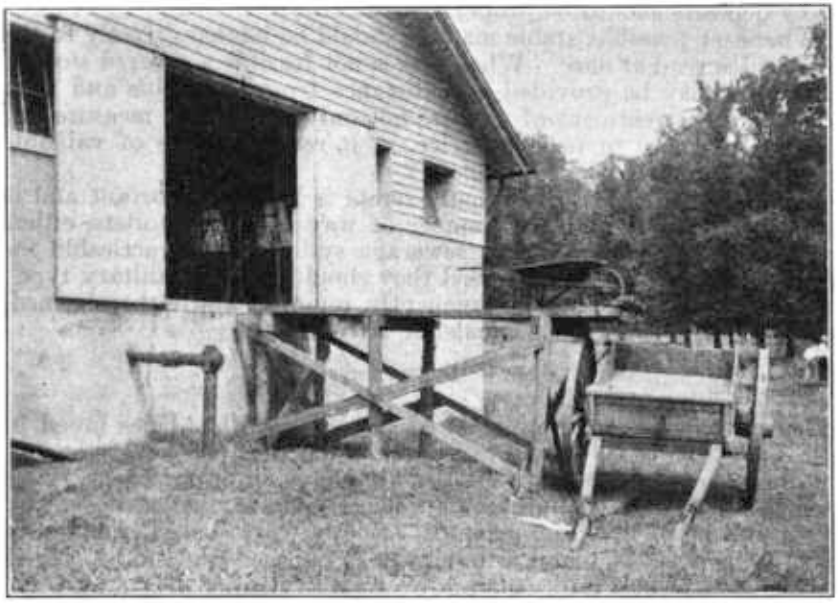


FIG. 1.—A simple and efficient way of handling manure on a small dairy farm. The direct haul to the field reduces manure losses and keeps the barnyard clean

Source of trouble	Remedy
Body of the cow.	Clean cows. Small-top milking pails.
Unclean utensils.	Thorough washing and sterilization.
Growth of bacteria.	Prompt cooling and storage at low temperatures.[11]

CLEAN COWS

Clean the cow.

The body of the cow, especially that part of the belly, flanks, and udder that is immediately above the milk pail, may be the source of

[11] Farmers' Bulletin 976 gives details of milk cooling.

many bacteria in the milk. Manure, loose hairs, bedding, and other foreign matter carrying great numbers of bacteria drop into the pail during the milking. In fact, samples of fresh cow manure have been known to contain nearly 50,000,000 bacteria per gram. There are 453.6 grams in 1 pound.

The best method of prevention is to have the cows clean at milking time. Far more reason exists for the daily grooming of a cow that produces human food than of a horse. Custom, however, demands that the horse be kept clean, and that custom should include cows on farms where milk is produced. Cows on pasture usually keep cleaner than when in the barn, but though they appear clean they may be very dusty and need to be brushed before each milking.

FIG. 2.—Cleaning off the cows in a modern dairy barn. A clean cow is the first step in the production of clean milk

When kept in stables cows require a thorough grooming at least once every day. It is well to clip the long hairs from the udder, flanks, and tail, in order that dirt may not cling to them. Before milking, the udders, flanks, and bellies of all cows should be carefully wiped with a clean, damp cloth to remove any dust or loose hairs. If very dirty, these parts should be washed clean. Sufficient bedding, proper stable construction, and frequent removal of manure are also things which will aid in keeping the cows clean.

Cleaning cows has been found to have a marked effect in lowering the bacterial count. In an experiment in which open, sterilized milk pails were used, samples of fresh milk from dirty cows had an average bacterial count of 55,208 per cubic centimeter, while samples of fresh milk from clean cows with udders and teats washed had an

average count of only 4,947 bacteria per cubic centimeter. (A cubic centimeter is about 16 drops.)

SMALL-TOP MILK PAILS

Use small-top pails.

Most of the dirt in milk falls from the body of the cow into the pail at milking time; hence it is easy to see the value of a pail which is partly covered. The use of such a pail results in a lower bacterial count and in less sediment in the milk, because it has only a small opening into which dirt may fall. Small-top milk pails should be durable, have smooth seams, be easy to milk into, be easily cleaned, and have only a small opening. A number of such pails are on the market, but any tinner can convert an ordinary pail into a small-top pail very cheaply by the addition of a hood, as shown in Figure 3.

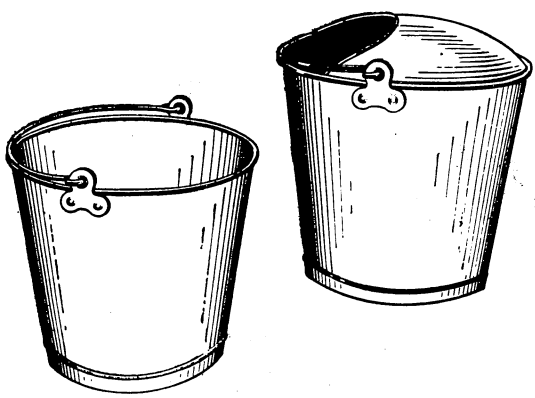


FIG. 3.—Open and small-top milk pails.

The use of a small-top pail may seem awkward at first, but it will soon be found that milk can easily be drawn into the opening. The reduction in the quantity of dirt in the milk as shown on the strainer will be surprising. In nearly every case where the small-top pail is used there is less sediment in the milk, as shown by the resulting cotton disks after milk is run through a sediment tester. For example, the average number of bacteria per cubic centimeter in 30 samples drawn into a small-top pail was found to be 29,263, while an equal number of samples drawn into an open pail averaged 87,380.

WASHING AND STERILIZING UTENSILS[12]

Wash and sterilize dairy utensils.

Dairy utensils which have not been properly washed and sterilized contain large numbers of bacteria. Indeed, dirty utensils are usually the source of most bacteria found in market milk at the time of its production and before bacterial growth has begun. Experiments have furnished convincing proof of the contamination of milk by unsterilized utensils. In one experiment milk drawn into sterilized pails had an average of only 6,306 bacteria per cubic centimeter, while samples from unsterilized pails averaged 73,308.

Besides adding large numbers of bacteria to milk, unsterilized utensils usually add undesirable types of bacteria. Such types are the ones that cause milk to putrefy and undergo changes that may make it dangerous. Furthermore, if utensils have been washed in

[12] The word "utensils" as used in this bulletin means any appliance which comes into contact with milk or cream during production or handling. It includes such articles as milk pails, strainers, cans, separator parts, milk bottles, etc.

contaminated water and are not sterilized, disease bacteria may be introduced into the milk.

Cans which have not been properly sterilized and dried give off foul odors after having stood for a while tightly covered. This is due to the action of decay-causing bacteria on particles of milk solids left in the cans. If such a can is washed and sterilized thoroughly the foul odor will disappear, and will not return upon standing. Utensils should be washed and sterilized immediately after use in order to prevent the multiplication of great numbers of bacteria on the inner surface of the utensils. In one experiment, milk showed 666,520 bacteria per cubic centimeter after coming in contact with unsterilized utensils, even though the utensils had been washed (but not sterilized) immediately after milking. In similar tests in which 8 hours were allowed to elapse before washing, the average bacterial count of the milk was 1,667,000, or more than a million greater than when the utensils were washed immediately.

The best remedies for dirty utensils are plenty of hot water, an alkali washing powder, a stiff brush, and steam. First of all, the utensils must be thoroughly cleansed, as sterilization is not a substitute for washing. First, rinse the utensils in cold or lukewarm water, then wash thoroughly until clean with hot water and washing powder, using a stiff brush. Avoid rags, greasy soaps, and soap powders.

Sterilization is best accomplished with steam. Proper sterilization not only kills bacteria but heats the utensils enough to dry them immediately, thus preventing rust. Where steam is not available utensils may be immersed in water and boiled for 5 to 10 minutes, but this method is cumbersome. Steam for dairy utensils is available for even the smallest dairies, by means of a simple steam sterilizer.

Moderate-sized dairies of 20 cows or more, however, should install sterilizing equipment of greater capacity. This may be a metal tank[13] on a brick or masonry foundation as shown in Figure 5. Enough water for washing utensils is put into the tank and a fire built beneath. When the water is hot, it is drawn off to use for washing, leaving only about 1 inch in the tank. After the utensils are washed they are placed in the tank on a false bottom which is slightly higher than the water remaining in the tank. The cover is then placed tightly over the tank. Sufficient steam is generated from the boiling water to sterilize the utensils in 30 minutes. This type of sterilizer is also suitable for milk bottles, which can not be conveniently sterilized with the small apparatus previously referred to.

In the larger dairies, in any dairy in fact, a steam boiler furnishes the best source of steam for sterilization. The boiler can be connected with a sterilizing oven built of concrete, brick, stone, tile, metal, or wood. The utensils should be placed in the oven and steamed for at least 15 minutes. The steam coil placed in the bottom of the oven should furnish heat enough to dry the utensils after sterilization. They may then be left in the sterilizer until used.[14] Thorough drying of dairy utensils after washing and sterilization

[13] Farmers' Bulletin 1473, Washing and Sterilizing Farm Milk Utensils.

[14] Plans for the construction of a sterilizing oven can be obtained free from the Bureau of Dairy Industry, United States Department of Agriculture.

is extremely important. The sterilizing process, if properly performed, should heat the utensils to such a temperature that they will dry quickly.

Particular attention should be paid to the sterilizing temperature, which should be at least 205° F., and for the purpose the constant

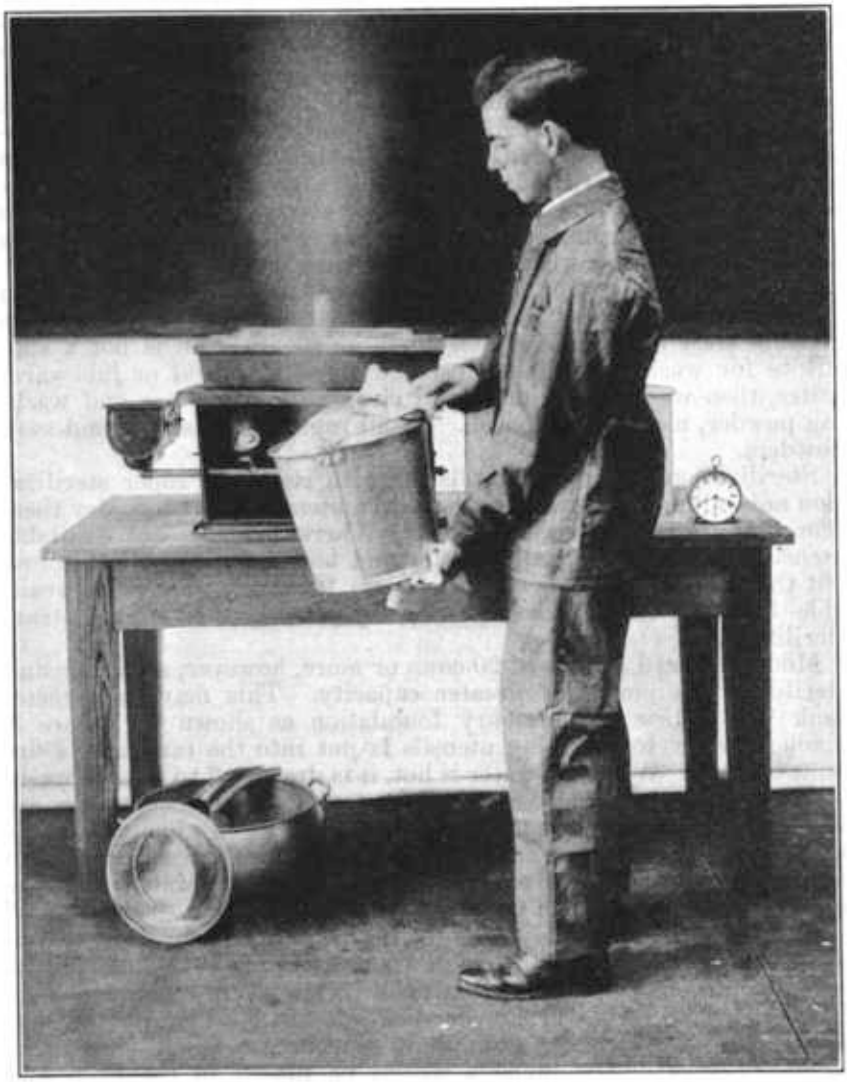


FIG. 4.—Sterilizing dairy utensils with a simple steam sterilizer

use of a thermometer is advised. Utensils should be left exposed to a temperature of 205° F. or more for at least 5 minutes. Some types of sterilizers generate steam slowly and the length of exposure at 205° F. should be noted rather than the time the sterilizer is in operation.

If the simple steam sterilizer shown in Figure 4 is used, utensils should be inverted in a clean, dry place, free from dust (preferably a room in the milk house), and should not be touched until needed.

PREVENTING GROWTH OF BACTERIA

Milk and cream should be cooled and kept cool.

Generally, the larger numbers of bacteria found in market milk when it reaches the consumer are due more to the multiplication of the bacteria than to the original contamination. This great multiplication occurs because the milk is not properly cooled during storage, transportation, and delivery. The rapidity with which bacteria multiply in milk at different temperatures is shown in Table 1.

TABLE 1.—*Growth of bacteria when milk is held at 50° F. and at 68° F.*

Temperature of milk (°F.)	Number of bacteria per cubic centimeter				
	At beginning	At end of 6 hours	At end of 12 hours	At end of 24 hours	At end of 40 hours
50	10	12	15	41	62
68	10	17	242	61,280	3,574,990

At the above rate if the milk had contained 1,000 bacteria per cubic centimeter at the beginning, the part held at 50° F. would have contained 4,100 bacteria at the end of 24 hours while that held at 68° F. would have contained 6,128,000. The effect of temperature upon the growth of bacteria is shown graphically in Figure 6.

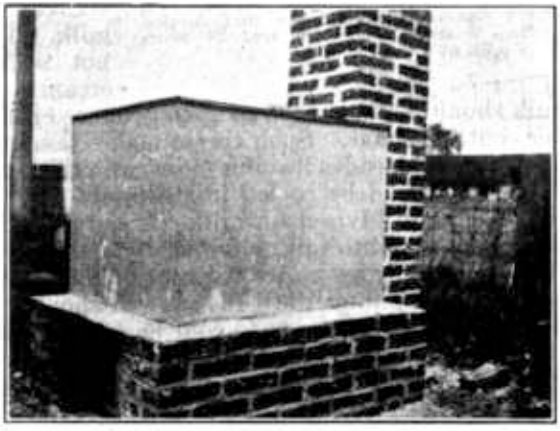


FIG. 5.—Hot-water heater and sterilizer

Commercial experience confirms the results of experimental work. Milk which has been held for several hours without proper refrigeration nearly always shows higher counts than fresh milk from the same source. At a certain creamery, milk received in the morning consisted of the previous night's milk and fresh morning's milk, which were kept separate. During six summer months, from April to September, inclusive, 478 samples of the morning's milk showed an average bacterial count of 800,026, while 366 samples of milk which had been held overnight on the farms had an average bacterial content of 2,406,357 bacteria per cubic centimeter.

A survey of the temperature at which milk is received at railroad stations for shipment to market during the hot months showed the average temperature of morning's milk to be about 60° F., and in some cases it was as high as 80° F. These temperatures are much too high to permit milk to be shipped a considerable distance without souring. Frequently it was found that morning's milk was rushed from the farm to the station insufficiently cooled. A large part of the annual loss from sour milk is due to the shipping of milk at too high a temperature.[15]

Milk or cream must be cooled promptly to a temperature of 50° F. or below if rapid bacterial growth is to be prevented.

The use of a surface cooler is especially necessary when the time between milking and shipping is short. If warm milk is run over a surface cooler and then set in a tank cooled with ice to 40° F. or below, it should not be difficult to cool milk to 50° F. within an hour after it leaves the cow. The fact that precooling with a surface cooler is not practiced, and that ice is not put into the cooling tank until after the milk is put there, is the cause of much milk reaching the shipping station in summer at so high a temperature that it sours on the way to the city.

The best and quickest way to cool milk to 50° F. is to cool it over a surface cooler with the coldest available water and then set the cans of milk in a well-insulated tank, the water of which is below 40° F.[16] (Figure 7.)

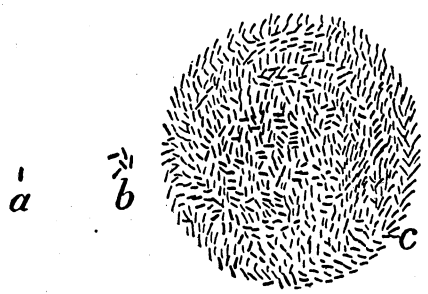


FIG. 6.—This diagram (after Conn) shows the rapidity with which bacteria multiply in milk not properly cooled. A single bacterium (*a*) in 24 hours multiplied to 5 (*b*) in milk kept at 50° F.; (*c*) represents the number that develop from a single bacterium kept 24 hours in milk at 70° F.

A 10-gallon can of warm milk precooled with water at 55° F. and set in a tank of ice water at 37° F. can usually be cooled to 50° F. in about 20 minutes.

Cream sours more slowly than milk. Thick or rich cream does not sour so quickly as thin cream; therefore, ordinarily, milk should be separated so as to produce cream testing from 30 to 35 per cent butterfat. Such cream makes less bulk to handle and sours more slowly, besides leaving more skim milk on the farm.

Cream should be cooled immediately after it is separated by the same methods advised for milk. If only a small quantity is handled, it may be put into tall cylindrical cans, called "shotgun" cans, and these placed in ice water. Fresh cream should not be mixed with previous skimmings until it has been thoroughly cooled, because the addition of warm cream to cold hastens souring by warming up the whole mass.

MATERIAL AIDS IN DAIRYING AND GENERAL CLEANLINESS

The matters discussed under this heading have only a slight influence upon the bacterial count of milk, but they must not be neglected by the successful dairyman. They are valuable to him and to the industry as a whole. Many of them tend to make work lighter and add to the health and production of the herd. For instance, a cow

[15] Farmers' Bulletin 976, Cooling Milk and Cream on the Farm.
[16] Farmers' Bulletin 976.

stable with smooth walls and a tight floor may be cleaned with very little labor. In such a stable it is possible to save all the liquid manure, which is valuable in the field but not under the barn. Abundant light and proper ventilation in the barn will do much to maintain health and comfort in the herd. In fact, it can be safely stated that by following these lesser guides to sanitary milk production the dairyman will get returns in labor saved, increased milk production, and greater vitality in the herd.

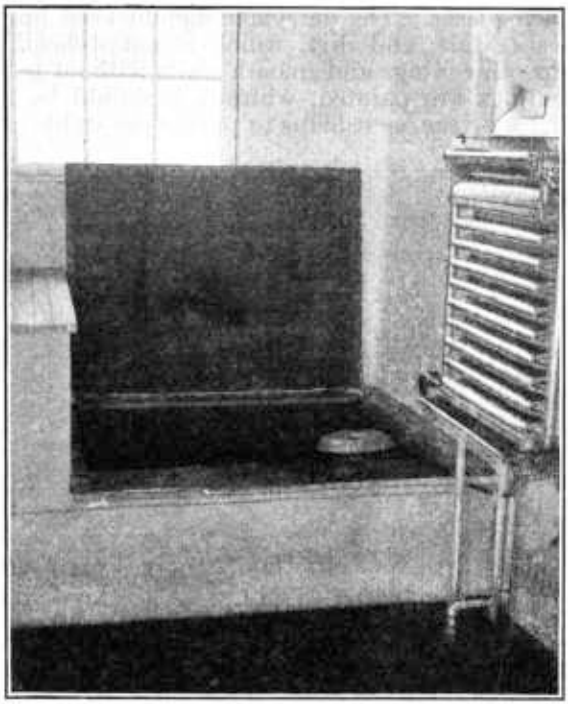


FIG. 7.—Homemade cement tank for cooling milk and cream

STABLE

Have the cow stable clean, well lighted, and well ventilated.

Whenever possible, the stable should be on high ground with good natural drainage. Poultry houses, privies, hog sheds, manure piles, or surroundings which pollute the stable air and furnish breeding places for flies should be at a distance from the cow stable. An ideal site for a barnyard is on a south slope which drains away from the stable. If the barnyard is inclined to be muddy it may be improved by drainage and by the use of cinders or gravel. A clean yard is a great help in keeping the cows from becoming soiled with mud and manure.

The stable should have a hard, waterproof floor which can be readily cleaned. A dirt floor is very undesirable. A concrete floor is easily cleaned and prevents waste of the liquid manure, but tends to be cold; however, extra bedding for the cows to lie on will remedy this trouble. The gutter back of the cows should be large enough to hold the droppings; a width of from 16 to 18 inches with a depth of 7 inches usually is sufficient. The gutter should incline so as to drain readily, unless the liquid is taken up by absorbents.

Types of stalls and mangers which present the least possible surface for collecting dust and dirt and the least obstruction to the circulation of air are the most satisfactory from the sanitary point of view. Stalls of wood have many flat surfaces and cracks which are difficult to keep clean, and in case of outbreaks of disease are not so easy to disinfect thoroughly as stalls made of metal pipes. A swing

stanchion is usually preferred, as it allows the cow plenty of freedom. A low, smooth manger without sharp angles is easy to keep clean. If the cows are tied facing the center of the barn the walkway behind them should be 5 feet or more in width so that the walls will not be soiled by the spattering from the gutter and the manure carrier.

The most common defect in dairy stables is a lack of cleanliness; cobwebs on the ceilings and manure on the walls are too common in such places. The dairyman should keep his stables free from cobwebs, dust, and dirt, which is not difficult if stables have tight, smooth ceilings and smooth walls without ledges. Unless walls and ceilings are painted, whitewash should be freely applied at least twice a year, as it helps to purify the stable and to keep it light.

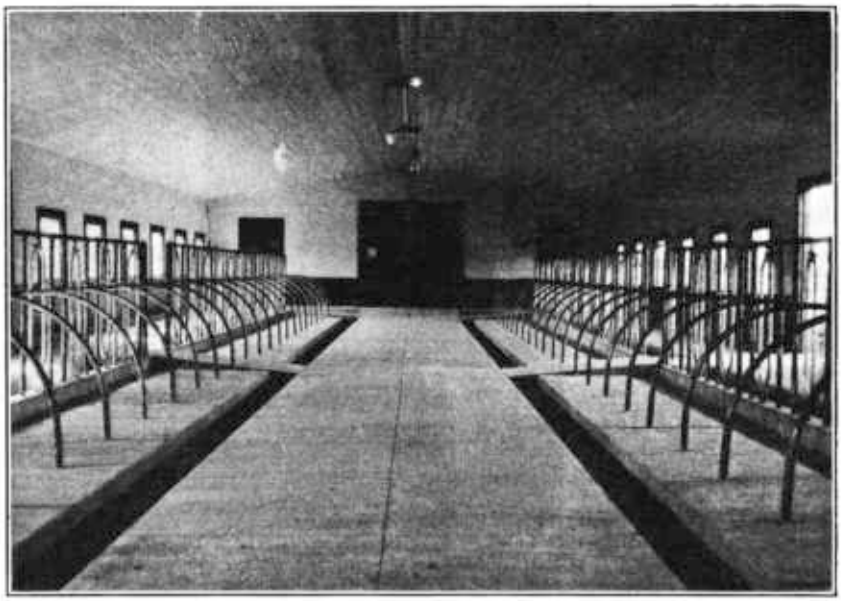


FIG. 8.—Interior of the dairy stable on the farm of the U. S. Naval Academy. The construction is such as to minimize the labor necessary to keep floor, walls, ceiling, and stable fittings in a clean and sanitary condition

An abundance of light is necessary; 4 square feet of glass per cow is generally sufficient if the windows are well distributed and not obstructed in any way. If the stable is built with its length north and south it receives the purifying benefit of both the morning and afternoon sunlight.

Every cow stable should have a system of ventilation to keep the air fresh and pure and the cows comfortable without exposing them to injurious drafts. If the odor in the stable is disagreeable at any time, it indicates that the ventilation is deficient. At least 500 cubic feet of air space should be provided for each cow. Farmers who desire to provide proper ventilation in cow stables can obtain information on this point by applying to the Bureau of Dairying, United States Department of Agriculture.[17]

[17] Farmers' Bulletin 1393. Principles of Dairy Barn Ventilation.

MILK HOUSE

Convenience and thorough cleanliness are essential in the milk house.

The building in which the milk is handled should be convenient to the barn, but so placed as to be free from dust and stable odors. The ideal place for it is in a well-drained spot somewhat higher than the barn. It should not be near the barnyard, pigpen, privy, or other source of contamination. In cold climates it may be connected with the stable by a covered but well-ventilated passageway with self-closing doors at each end to prevent stable odors from passing to the milk house. With proper precautions the milk house may be in the same building as the stable, but it should be provided with a separate entrance and the walls should be tight and without a direct communicating door or window.

FIG. 9.—A sanitary but convenient and inexpensive milk house built according to plans recommended by the United States Department of Agriculture

The principal purpose in building a milk house is to provide a clean place where dairy products may be handled. It is advisable to divide the house, handling the milk in one room and washing the utensils in another. The milk house and all its equipment should be so planned that unnecessary steps will be avoided and labor economized to the greatest extent. Plans for milk houses are given in Farmers' Bulletin 1214.

Thorough cleanliness must always be kept in mind; therefore there should be no unnecessary ledges or rough surfaces inside the building to prevent it from being quickly and thoroughly cleaned. Milk-house floors should be of concrete and pitched to drain through bell traps. Rounded edges at the walls prevent the collection of dust or dirt and make the room easier to clean. The walls and ceilings may be made of matched boards, but smooth cement plaster on metal lathing is better. Ventilators are necessary to keep the air in the milk room fresh and free from musty and other undesirable

odors, and to carry off steam from the wash room. Windows are of prime importance, as they let in fresh air and sunlight and facilitate work. In summer the doors and windows should be screened to keep out flies and other insects.

It is convenient to have a plentiful supply of cold, running water at the milk house. The supply may be piped from an elevated tank fed by a windmill, engine, hand pump, or hydraulic ram. The dairyman can ill afford to spend his time in carrying water in a pail to cool his milk and wash his utensils. Provision must also be made for supplying an abundance of hot water to clean and wash utensils.

UTENSILS

Have utensils that are easily cleaned.

All utensils which come in contact with milk should be made of durable, smooth, nonabsorbent material. Wooden utensils are hard to sterilize and should never be used for milk. Badly battered or rusty utensils are objectionable, as they are hard to clean, and contact with rusty iron may injure the flavor of milk and milk products. Avoid all utensils having complicated parts, crevices, or inacccessible places which are hard to clean properly.

MILKING AND CARE OF MILK

Have clean suits for the milkers; keep the milk clean and cool.

After the cows are prepared for milking, each milker should wash his hands thoroughly with soap and water and put on a pair of clean overalls and a jumper, or wear a suit which is used for no other purpose. Suits enough should be provided so that a clean one is always available. They should be washed regularly, and occasionally they should be sterilized with steam or boiled. Even the milk stool should be clean to avoid soiling the milker's hands.

Milking should be performed only with clean, dry hands, or with a properly cleaned and sterilized milk machine,[18] The practice of wetting the hands with milk is a filthy one; it adds bacteria and sediment to the milk, and is liable to cause the cows' teats to chap in the wintertime. Milking should be done quickly and thoroughly, without violent jerking of the teats.

After each cow is milked the pail of milk should be removed immediately to the milk house. Pails of milk should not be allowed to stand in the barn. The milker should remember always that he is handling a human food which is very easily contaminated. Therefore it would be well that soap, clean water, and towels should be readily accessible so that the hands may be washed after milking each cow.

After milk is taken to the milk house it should be weighed, strained, and cooled at once. The object of weighing is to keep the record of the yield of each cow so as to determine the profitable and unprofitable cows in the herd. All milk should be strained to remove any insoluble dirt that may have fallen into it. This is best done through a layer of sterile absorbent cotton placed between two

[18] Farmers' Bulletin 1315, Cleaning Milking Machines.

clean, sterilized strainer cloths, or through special straining cloth. Straining milk improves its appearance, but does not remove the bacteria carried into it by dirt; therefore dirt should be kept out of milk by cleanly methods. A supply of strainer cloths should be ready for use at all times, so that when one becomes soiled another can be substituted immediately. Strainer cloths should be used but once. Special strainer cloths may be procured at low cost from most dealers in dairy supplies.

While cooling and in storage the cans of milk should be kept covered to prevent the entrance of dust, dirt, insects, and other sources of contamination. Warm, fresh milk should not be mixed with the cold milk of the previous milking, as such a practice results in warming up the milk which has previously been cooled.

Fig. 10.—Milk iced in crate, ready for transportation

Milk should be promptly cooled and kept cool. It should be kept in ice water until it is loaded on the wagon to go to the station or receiving plant. Bottled milk may be kept cold during transportation by the use of cracked ice placed in the crates. Cans of milk may be protected from the heat of the sun by jackets or by blankets, which will help keep the milk cool and in winter will provide a covering for the milk to prevent freezing.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	————, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1930